Inventory of carbon sequestration in Artemisia lands of Hamadan province

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Abstract. Climate change is one of the most important challenges in sustainable development which has negative effect on terrestrial and aquatic ecosystem. The lead factor of this phenomenon is Co2 accumulation in atmosphere. One of the suitable ways of facing the mentioned issue is carbon sequestration in plant biomass and soil as a simple as well as inexpensive refined way in rangelands. With respect to the fact that Artemisia lands occupy an extensive part of the rangelands in Iran, in order to investigate the role of Artemisia lands in carbon sequestration, an area of *Artemisia sieberi* vegetation type in Hamadan province was selected and the content of aboveground and underground biomass carbon and soil organic carbon was determined. The result showed that the total carbon sequestration per hectare was 287.49 kg/ha and 90% of total carbon sequestration was soil organic carbon. The results of biomass carbon distribution showed that the carbon content in aerial biomass was more than underground biomass. Among the different parts of aerial biomass, the greatest storage was related to foliage carbon. Within proper range management in rangeland ecosystems, a major step forward in rising plant biomass could be taken. On the other hand, any attempt to restore lost natural resources could increase carbon sequestration.

Keywords: Carbon sequestration, soil carbon, Biomass, Artemisia lands.

1 Introduction

Climate change is one of the most important challenges in sustainable development that bears a negative effect on aquatic and terrestrial ecosystems. The lead factor of climate change is co2 accumulation in atmosphere (Petit et al, 1999).For the reason that reduction of co2 in atmosphere by artificial ways is extremely expensive (Cannel et al, 1992) thus carbon sequestration is the simplest and the most economically practical way in order to face with climate change crisis

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(Dixon et al 1997).One of the suitable options for carbon sequestration is arid and semi arid rangelands. Rangelands occupy approximately half of the area of dry lands and over one third of underground and aboveground storages of carbon in dry lands is located within them (Allen-Diaz1996).Although the aerial and underground parts in rangelands compared to forests are lesser but they play a more striking role in carbon sequestration as they are more expansive than forests comprising 38% of dry lands (Lciuk et al, 2000 and Snorronson et al, 2002).

Schuman et al (1999) indicated that live stock grazing results in an increase in soil carbon content in depth of 30 centimeter rather than treatments without grazing. Sing etal (2003) in India stated that there was appositive relation between soil organic carbon and vegetation cover. In this study, the content of carbon in plant organ and soil in a favorable vegetation cover was estimated about 1.96 -2.83 and 3.06-6.38 per hectare respectively but in an unfavorable vegetation cover it was 0.24-1.37 and 1.13-5.18 per hectare. Aradottir etal (2000) concluded that the amount of carbon differs among the methods of reviving dry lands. However, as a basic principle the amount of carbon in soil is more than that in root biomass but the carbon storage in aerial biomass rises across the time rather than the soil and the amount of aerial biomass is mostly more than the roots. Abdi (2005) reached a conclusion on estimation of carbon sequestration in Astragalus lands located in Markazi province that soil organic carbon forms 87%of total carbon sequestration. And the results of total biomass emission showed that carbon storage in aerial biomass has been more than roots. Also, there was a significantly positive correlation between carbon sequestration with shrub's volume as well as height, total biomass, litter and soil organic carbon.

Kolahchi (2005) drew a conclusion from investigation of carbon sequestration content in dominant shrubs and soil of enclosed pastures located in Heidarposht Hamadan province that the major amount of carbon sequestration was for Astragalus lands and there is a significant relation between slope direction and vegetation cover. On the other hand, the content of increase in soil organic carbon is not a function of height shifts.

Aghafashami (2007) on cognition of pasture potential to store carbon sequestration in southern of central Alborz in either of grazed and enclosed parts for two types of forbs and shrubs concluded that there was not a significant relation between plant carbon of shrub lands in either of grazed and enclosed parts at the level of 5% and no significant difference was observed between the types of shrubs and forbs through comparing these factors among them at the level of 5%. Also, the amount of soil organic carbon in grazing conditions has been greater than that of enclosed pastures.

Mahdavi (2008) through investigating the effect of plant distance Planting distance, pruning height and pruning time upon the amount of carbon sequestration in *Atriplex lentiformis* in Isfahan Ardestan found that there was a significant difference between planting distance and pruning height with carbon storage of aerial biomass as well as root at the level of 5 %. But none of these treatments bore a significant effect upon soil organic carbon storage.

Pastures are the most expansive vital lands in Iran with an area of about 86 million hectares. UN office of civil (2000) announced that the pastures in Iran bear a great capacity by 1 million ton carbon for carbon sequestration, Provided that they are to be revived. Regarding the fact that *Artemisia sieberi* is considered as a dominant shrub species in arid and semi arid rangelands, it is of great importance for forage production of livestock, erosion resistance as well as soil preservation. Besides, it could be of wider significance for bioenvironmental aspects like carbon sequestration. Thus, this study has been launched to find out the amount of carbon storage in various parts of Artemisia including aerial parts (leaves and stem) as well as root. Also, the relation between the amount of carbon in these organs within each other and soil carbon was investigated.

2 Materials and Methods

2.1 Study area

The area at issue is located in 49 13 11 longitude and 35 16 13 latitude, 18 km away from east of Rezen, in the north east of Hamadan that is considered as up-country pastures of Hamadan province. the climate is cold step, semi arid with long term mean of rain about 342.9 mm, soil texture is clay to clay-loam with a height of 1850 to 1900 m above the surface of sea (Anonymous,2005).

2.2 Sampling method

After gathering of documentary information and present maps of the study area, using minimal area, an area of 1m2 was designated for each plot. Regarding the vegetative condition of the site, 30 plots were applied. Then, after determining the number and dimention of plot, certain points were plotted through which despite of production, percentage of vegetation cover, percentage of stone, percentage of bare soil as well as litter were measured. In order to evaluate the aerial biomass in Aremisia, clipping method was used up. concerning the matter that shrubs have a strong root system, in addition, the proportion of stem to root in arid and semi arid areas is more than one, samples were taken from the depth of 15 cm of soil surface to assess the amount of carbon sequestration.

After transferring the samples to the laboratory, samples of stem, leaf and root were isolated then soon after being dryed in fresh air, Combustion in an electric furnace method was used up that last for 3 hours in 550 cg then, the amount of organic carbon was determined by the residual weigh of ash. The measurement of organic soil was taken upon Valk Black method (MacDicken, 1997 and Jafari, 2003).

2.4 Analyzing method

First, minimum and maximum mean as well as standard variance of the measured features in plots was taken. In order to analyze data, Spss13 and Minitab were applied. At the beginning concerning the matter that the units of dependent and independent units were distinctly different, all the data were standardized then, normalizing was carried out and using normalized data, regressive analyzing was conducted. To find out the relation between vegetation cover, soil, topography as well as carbon sequestration, correlation indices were calculated by Pierson method among the factors.

3 Results

The summary of statistics including minimum and maximum mean as well as standard variation on total mean of whole plots of the area at issue has been given in table 1.total sequestered carbon per unit area in the study area was 287.86 kg/ha, of the total sequestered carbon, soil organic carbon content was 259.12 kg (90%), biomass carbon content was 28.74 (10%) (table1). The results indicated that of the total sequestered carbon in biomass, 68.89%, 31.1% have been related to aerial and underground biomass respectively.

Table 1. Summary of statistics including minimum and maximum mean as well as standard variation on mean of 30 plots in Gharaghie.

feature	Standard variation	maximum	minimum	mean
Height above the surface of sea	10.75	1889	1850	1868.76
Soil apparent weigh g/cm3	0.19	1.68	1.01	1.38
Slope percent	2.42	9.76	0	4.41
Vegetatio n cover percent	9.32	73	38	54.8

Stone percent	6.57	28	3	13.4
Litter percent	3.76	19	4	12.26
Naked soil percent	10.01	43	3	19.33
Soil carbon kg/ha	5.1	34.11	5.13	14.85
Stem carbon kg/ha	1.7	11.37	1.78	4.95
Root carbon kg/ha	3.61	15.74	3.51	8.94
Total biomass carbon kg/ha	3.47	20.4	3.47	28.74
Soil organic carbon kg/ha	116.35	447.61	99.36	259.12
Total carbon sequestration	126.1	127.2	27.44	287.86

3.1 Regressive equations among carbon storage (leaf, stem, and root) and vegetation factors, topography, soil:

A- Leaf carbon

Leaf carbon as a dependent variable as well as soil factors, vegetation cover and topography as independent variables were investigated. Results of table 2 indicated that leaf carbon was related just with stem carbon that correlation index by 99% and the relation between these two variables were significant at least at the level of 1%.

The regressive model will be in this way:

$$C1 = Cst + 3.33 \qquad (1)$$

Table 2. results of regression analyze of leaf carbon with stem carbon in Gharaghie

Significance level	Leaf carbon	assumption
0.0001	99%	Stem carbon

B- Root carbon

Root carbon as a dependent variable and litter as independent were studied and the results of table 2 illustrates that root carbon was significantly related just with stone percent and bare soil percent. The relation index among these two variables was 90% and the relation between these two variables was significant at least at the level of 65%.Regressive model will be:

$$Cr = 0.586Lt + 2.87 \qquad (2)$$

Table 2. results of regression analyze of root carbon with litter in Gharaghie

Significance level	Root carbon	assumption
0.016	65%	Stem carbon

C- Soil organic carbon

Soil organic carbon as dependent variable and the other elements as independent were investigated and the results in table 3 showed that there is a significant relation between soil organic carbon with soil bulk density and leaf carbon. Correlation index among these two factors (soil organic carbon and soil bulk density has been 99% and the relation between these two variables has been significant at the confidence level of 75%. Correlation index between two variables equals with 98% and the relation between two variables has been significant at least at the confidence level of 43%. The multiple regression model of soil carbon with soil bulk density is:

$$Cs = 0.614Wt - 42.1 \qquad (3)$$

The multiple regression model of soil carbon with leaf carbon is:

$$Cs = 0.437C1 - 6.12 \qquad (4)$$

Table 3. Results of regression analyze of soil organic carbon with soil bulk density and leaf carbon in Gharaghie

Significance level	Soil organic carbon	assumption
0.007	0.75	soil bulk density
0.02	0.43	Leaf carbon

4 Discussion

The total mean of carbon sequestered was estimated about 287.49 kg/ha. Regarding the fact that of the total carbon sequestration, the content of soil carbon has been more than 90%.thus, it could be stated that, range land ecosystems especially soil of Artemisia lands is the most important organic carbon resource. Researches carried out by Aradotir etal (2000) confirmed this issue. The results of total biomass carbon emission showed that the storage of carbon in aerial biomass is more than roots. Aradotir etal (2000) observed similar results. According to the correlation indices among the features at issue (table 2) there was a positive relation between soil organic carbon and soil bulk density .This content was the greatest in western slopes that on account of the highest percentage of vegetation cover as a result of which, the highest amount of litter in soil, it has the greatest soil bulk density and the greatest amount of soil organic carbon as well. These results are similar to Kolahchi (2005). Soil organic carbon and leaf as well as stem carbon were positively related. Soil organic carbon is dependent upon plant organ carbon. Abdi (2005) and Agha fashami (2007) observed similar results. There was a significantly negative relation among vegetation cover and slope direction. The percentage of vegetation cover in northern and eastern slopes was greater than that of southern and eastern slopes and it was due to Angle of solar radiation and following that, the litter content of the soil surface is depleted as well. Kolahchi (2005) observed similar results. With regard to the results of carbon content among different parts of plant, leaf carbon was the greatest of all (14.85kg/ha) and for the reason that *Artemisia sieberi* is a deciduous plant, the content of annual sequestered carbon of leaves is precisely related to that year which involves 52% of sequestered carbon of plant. The amount of sequestered carbon of the other plant organs depends upon the content of sequestered carbon in leaf in a way that a positive relation was observed among leaf and stem carbon.

Generally it could be concluded that the total carbon sequestration in unit area Artemisia lands is related to vegetation cover, biomass as well as its components, soil organic carbon and litter. In order to make an increase in carbon sequestration these three factors: soil, biomass and litter should be taken in to account and any fluctuation on these factors will affect carbon storage. Thus, within proper range management in rangeland ecosystems, a major step forward in rising plant biomass could be taken. On the other hand, any attempt to restore lost natural resources could increase carbon sequestration. Regarding the fact that a large proportion of sequestered carbon was in soil, therefore, each biological or mechanical procedure preventing downward trend of soil will be a positive step to manage carbon sequestration (Izaurralde etal, 2007). Range management should involve everything in a way that in addition to sustainable exploit, carbon sequestration should be considered as well.

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